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SCIENCE

FRIDAY, AUGUST 10, 1888.

WHILE THE LACK of reliable information prevents us from gaining an understanding of Stanley's fate and the ultimate objects of his expedition, news has been received as to the events in Khartum. In May two messengers arrived in Cairo, carrying brief notes from Slatin Bey and several other European captives of the Mahdi. The handwriting of the writers was recognized by their friends, so that there can be no doubt as to their being genuine. The fate of the captives is pitiful. Only the missionaries are at liberty, and they are allowed to make a living by selling boiled beans in the streets of Khartum. Lupton Bey, formerly governor of the province Bahr-el-Gazel, was made to work in the armory like a common Arab. Recently he has been employed in the mint of the Mahdi. Slatin Bey is made the Mahdi's runner, and has to hold his stirrup. Others are imprisoned, and the Mahdi threatens to execute them. The messengers describe the state of affairs in the Mahdi's province as miserable. The inhabitants of Khartum are said to be starving, and there is a great want of clothing and of money. Discord prevails between the followers of the Mahdi and several chiefs. One of the latter recently tried to gain his independence, but as the Mahdi's party was more numerous he submitted. Although a formal peace was made, the Mahdi made the chief a prisoner and had him hanged. The messenger says that a force of five hundred men of Turkish or Egyptian troops approaching from Wadi Halfa would be able to destroy the Mahdi's power. The tribes of the Sudan are discontented with his rule, and after a short time he would find himself deserted by everybody, a few fanatics excepted. It is considered impossible to ransom the prisoners, as caravans conveying money or goods would be robbed and murdered before arriving in Khartum. Last year a sheik of Berber offered to re-open the trade between Khartum and Egypt. Although the Mahdi was not unwilling to accept the offer, his council rejected it. This news is considered reliable, and shows the difficulties which would be encountered in an attempt to liberate the unfortunate captives. Various letters of Emin Pacha confirm these reports, for he describes the effect of the despotic rule of the Mahdi about in the same way. In how far, however, the subjected tribes would be ready to assist in an attack upon the Mahdi appears doubtful, as we might else expect that they would join Emin, whose difficulties seem to be comparatively great. From recent reports it would seem that the Mahdi is contemplating a new attack upon the Equatorial Province, and that Emin is going northward to meet him. This news must be received with due reserve, as it does not agree with former letters of Emin and the apparent decline of the Mahdi's power. The despatch says, "Two native messengers who were captured from an earlier expedition by tribes in the Uganda district, bordering on the Albert Nyanza, and who escaped from their captors about the beginning of April, have just arrived here. They report that Emin Bey was in a situation of great difficulty. Provisions were scarce, and difficult to procure, and his troops were beginning to be discouraged. On April 4 Emin received a summons from the Mahdi, dated Khartum, calling on him to surrender and to disband his troops, the Mahdi threatening to attack if Emin refused." It will be remembered that Emin kept up friendly relations with Uganda and Unyoro up to the end of last year, and that he was able to purchase supplies in Uganda. In November, 1887, he sent letters from the southern part of Lake Albert Nyanza, and stated that he was extending the limits of his province southward. Since the unex-

pected retreat of the Mahdi during the great war in the Sudan, he has not been molested by serious attacks from the north.

AT LAST THERE IS REASON to hope that the publications of the Geological Survey will be printed. There are now in the hands of the public printer more than forty volumes prepared by the Geological Survey and the Bureau of Ethnology. Among these are the annual reports of the Geological Survey for 1886 and 1887. The 'copy' of that of 1888 is also nearly ready. The Government Printing-Office is full of work from all of the departments, and which has been ordered by Congress, and, as a rule, it is left to the discretion of the public printer as to the order in which the work shall be done. The work of the Geological Survey and Bureau of Ethnology has generally been postponed. The appropriation for the printing of the publications of these two offices for the present fiscal year has been made a specific one: it cannot be used for any thing else. This will cause the public printer to do the work in order to get the money. Provision has been made for the printing of fifteen thousand extra copies of the annual reports of the Geological Survey, and six thousand copies of the bulletins of the Bureau of Ethnology for last year and this. The prompt issue of the publications of these two offices is certain to make them more popular, and to commend them more strongly to Congress for liberal support. They have gone on in the past, year after year, expending large sums of money, and making very little show in the way of printed matter in return for it. But this has not been the fault of Director Powell or of his assistants. They have prepared a great mass of matter, but the public printer has allowed it to accumulate in his office without putting it into type. It is now expected that the arrears of this work will be brought up during the coming year. The volumes that will appear during the next twelve months contain a great fund of popular and scientific matter.

THE APPROPRIATION OF \$250,000 for the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation, and the segregation of the irrigable lands, and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation, and to make the necessary maps, which was attached to the sundry civil appropriation bill by the Senate, will be agreed to by the House. A careful canvass of the members shows that a sufficient number will vote for it, whether the committee report favorably or otherwise upon it. In authorizing the beginning of this important work, the government enters upon an enterprise of greater magnitude than any of the kind it has ever engaged in. Director Powell of the Geological Survey has estimated, that, of the arid region, now not susceptible of cultivation, fifteen per cent, or 150,000 square miles, or an area exceeding that of one-half the land now cultivated in the United States, may be redeemed. At thirty dollars an acre, which is a low estimate of the value of the rich lands of the West when plentifully supplied with water, this land, which is now worth almost nothing, would have a value of \$2,880,000,000. By comparison the building of the Pacific Railroad sinks almost into insignificance as a means of adding to the wealth of the nation.

THE CENSUS MAPS OF THE UNITED STATES.

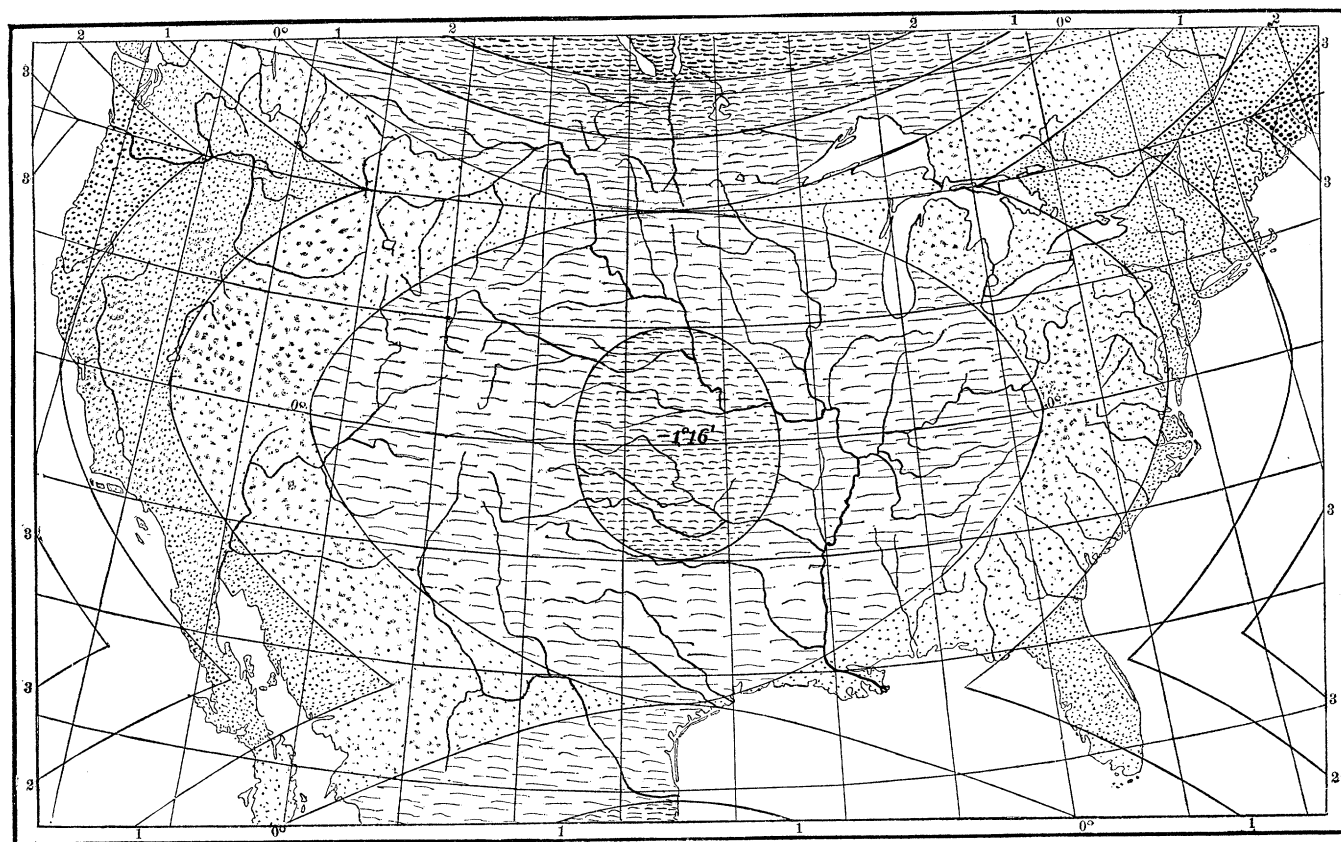
As the time is approaching for the Eleventh Census of the United States, the question whether the maps used for the purposes of the Tenth Census are satisfactory or not becomes impor-

tant and interesting. The making of a general map of the United States offers peculiar difficulties on account of the enormous size of the territory they occupy, which is so large that the curvature of the earth's surface has a very appreciable influence upon the map. This will be better understood by the fact that a circle circumscribed about the country cuts off a section of the globe of a little more than 42° aperture, its centre being situated north of Omaha. It is impossible to make a single map of the United States which in all its parts is an exact likeness of the country as it exists on the globe: therefore it is the task of the map-maker to find that method of projecting the country upon a flat piece of paper that results in alterations which are as slight as possible, and that agree best with the special object of the map.

We will consider in how far the existing maps satisfy this demand. On the accompanying map the polyconic projection of the Coast Survey which is in general use is shown in red. The lines of latitude and longitude are obtained in the following way. The portion of the globe situated between two parallels that are very

States with one another. But, besides this, the form of the single countries is distorted. We have indicated by arrows that direction in which the increase in the lengths of lines is a maximum. In the direction vertical to these arrows the decrease in the lengths of lines is a maximum. The distortion of each part of the map depends upon the relation of these two measures, and may be expressed by an angle. We observe on our map that this distortion exceeds 3° in the outlying parts of the country.

After having thus found the character of alterations in this map, we will proceed to consider whether it meets the demands that must be made upon such a map. The principal objection is, that the surfaces are very much enlarged in the outlying districts, which are at the same time among the most thickly settled. It is true that measurements may be made on sectional maps which have various central parallels; but when it is the object of the map to present at a single glance the relative extent of certain phenomena, of whatever character they may be, climatological, geological, or industrial, it is of prime importance that the surfaces in various parts



SKETCH-MAP OF THE UNITED STATES SHOWING THE DIFFERENCE BETWEEN THE DISTORTIONS IN THE POLYCONIC AND CONIC PROJECTIONS.

close together may be considered as part of a cone the apex of which lies on the axis of the earth. By developing this cone, the zone assumes the shape of a portion of a circular ring. One zone after another is thus developed. As the side of the cone varies according to the latitude of the zone, the rings do not exactly join each other; but this is remedied by enlarging the lengths of the meridians so as to fill up the gap. It will easily be understood that by this process those parts of the map lying far away from the central meridian will become distorted and too large. We will first study the enlargement of surfaces. On our map the lines on which the enlargement amounts to 1, 2, 3, 4, 5, and 6 per cent are indicated by heavy lines. Thus it will be seen, that while, in measuring a surface in the central points of the United States, we commit an error no greater than 1 per cent, the latter amounts to more than 6 per cent in the New England States and in California. If we have a large-scale map of the United States showing the distribution of forests, 10.6 square inches in New England will represent the same surface as 10 square inches in Minnesota. Thus we see that we cannot compare the surfaces of various parts of the United

of the map should be equivalent to each other. Maps which have this property are called 'authalic' or 'equivalent' maps, and we should say that it is the fundamental point that each map used for census purposes should be authalic.

But we might ask, if we agree that this should be the case, will not the alterations of angles become enormous, and thus our ideas of distances become altogether wrong? In order to satisfy this question, we must consider what means we have to preserve the same relation of surfaces all over the map, and at the same time to make the alteration of angles—and therefore that of distances also—as small as possible. We may first ask that this alteration be smaller than on the ordinary polyconic projection, and then we will have a map exceeding in value the former. But we present here a map that has not only slighter alterations of angles than the polyconic projection, but the surfaces of which are also preserved all over the map. While in the polyconic projection the alteration of angles very nearly reaches 4° , it does not exceed in our map $1^\circ 16'$. While the surfaces on the former projection are enlarged more than 6 per cent in the outlying regions, they are not at all altered

here. Besides this, the construction of the map is more simple than that of the polyconic map; the parallels being all concentric circles and the meridians straight lines, while in the polyconic projection each meridian must be constructed separately. But our projection has still another advantage; it is the best among all the authalic projections that are possible; that is to say, the maximum of distortion cannot be made smaller than it is in our map. A study of the map shows that the distortion reaches its maximum in the extreme southern part of the United States, in latitude 25° north, where it amounts to $1^{\circ} 16'$. Going north, it decreases rapidly, until in latitude $28^{\circ} 58' 49''$ it vanishes. Then it increases again quickly, and in $37^{\circ} 58' 16''$ again reaches its maximum of $1^{\circ} 16'$. Farther north it decreases, and on the parallel of $45^{\circ} 58' 55''$ there is no distortion. While in this zone (from $28^{\circ} 58' 49''$ to $45^{\circ} 58' 55''$) the maximum of increase of length is in the direction of the meridians, while the maximum of decrease is along the parallels, it is the reverse north and south of it. From the northern line, on which no distortion exists, it increases, and reaches $1^{\circ} 16'$ on the 49th parallel, the northern boundary of the United States. We have indicated by various shading the regions of equal distortion on both projections. The regions situated east and west of the line of $1^{\circ} 16'$ distortion on the polyconic map are in every respect inferior to our map. But it will be seen that the distortion of angles in the central part of the polyconic map is slighter than in our map. The central parts of our projection, on the other hand, are inferior to the polyconic projection so far as alteration of angles is concerned, while it is superior for census purposes as being equivalent. We must not, however, consider the central parts alone, as the map is intended as one of the United States, not of parts of the States. For the central parts alone, it would be necessary to adopt another equivalent projection. In our map on the lines of maximum distortion the lines whose lengths are increased are 1.1 per cent too long, while those vertical to them are 1.1 per cent too short: therefore this is the maximum error that can be made in measuring lengths. In the polyconic projection this error is equal to the amount of deformation of surface, being 6 per cent in the Eastern and Western States.

The sketch-map on p. 62 shows the difference between the distortions of angles in these two maps. In the shaded portions the polyconic projection has a slighter deformation of angles than our projection; in the dotted portions the reverse is the case. This comparison shows that in 48 per cent of the area of the United States the polyconic projection is superior to ours regarding deformation, the maximum difference in its favor being $1^{\circ} 16'$, while in 52 per cent of the area ours is superior, the maximum difference in its favor being nearly 4° . A comparison between the amount of deformation in both maps gives the following results:—

Deformation.	Per Cent of the Area of the United States.	
	Conic Projection.	Polyconic Projection.
$0^{\circ}-1^{\circ}$	51	58
$1^{\circ}-1^{\circ} 16'$	49	12
$1^{\circ} 16'-2^{\circ}$	—	15
$2^{\circ}-3^{\circ}$	—	13
$3^{\circ}-4^{\circ}$	—	2

From these remarks it appears that the conic projection excels the polyconic in every respect.

It appears from our map, very clearly, that the polyconic projection has the valuable property of having very slight distortions on a wide belt situated on both sides of the central meridian. This property makes it valuable for maps showing narrow strips of land only, such as coasts of the ocean and of lakes: therefore it is serviceable for the purposes of the Coast Survey, particularly as the alteration of surface is of little or no importance to the mariner. The United States, however, have a wide extent in longitude, and a far smaller one in latitude, which makes the projection not well adapted for a map of the whole country. If the object were to construct a map of the whole territory of the United States on this projection, we ought to make use of this fact. Our country is far

more extended in longitude than in latitude. But by assuming a system of parallels and meridians the pole of which is situated near latitude 12° north, longitude 175° west from Greenwich, and using this for a polyconic projection, the greatest distance from the new central meridian will be 13° instead of 30° , and the greatest distortion less than 1° instead of nearly 4° , while the increase of surface will be less than two per cent in the outlying portions. This projection may be considered quite a good one, as the central part of the country adjoining about the 40th parallel of latitude would have hardly any distortion. From this line it would increase very slowly northward and southward.

We said, however, above, that, for the purposes of a census, equivalence of surfaces must be the fundamental point of view for the construction of a map, and, as even the oblique projection just mentioned is not equivalent, it cannot be accepted. For the same reason it is necessary to take into account the spheroidal shape of the earth, which makes the computation of oblique projections difficult: therefore they will be only chosen if they offer great improvements upon others.

Assuming the central point of a circle circumscribed about the United States as a zenith, and computing a conical projection that is equivalent, and in which the alteration of angles is as slight as possible, we shall find that the maximum alteration of angle is not more than $58'$, the map including the whole territory of the United States. We should recommend this map, if it were not for the fact that there would be an open sector of 10° aperture running from the centre near Omaha to the northern boundary. This is produced by the development of the cone upon which the map has been projected. The existence of this open sector is so serious an objection, that the decrease of $18'$ in the deformation cannot be considered an equivalent.

By assuming an oblique conic projection the alteration of angle might be reduced to $1^{\circ} 9'$, but the difficulty of computing this projection for the spheroid induces us to discard it. A thorough investigation into the properties of all known projections leads us to the conclusion that the projection we propose here is the best that is possible for census purposes, and the only one that ought to be used for it. The easiness of computation of the elements adds to the properties that qualify it for an extensive use. Dr. F. BOAS.

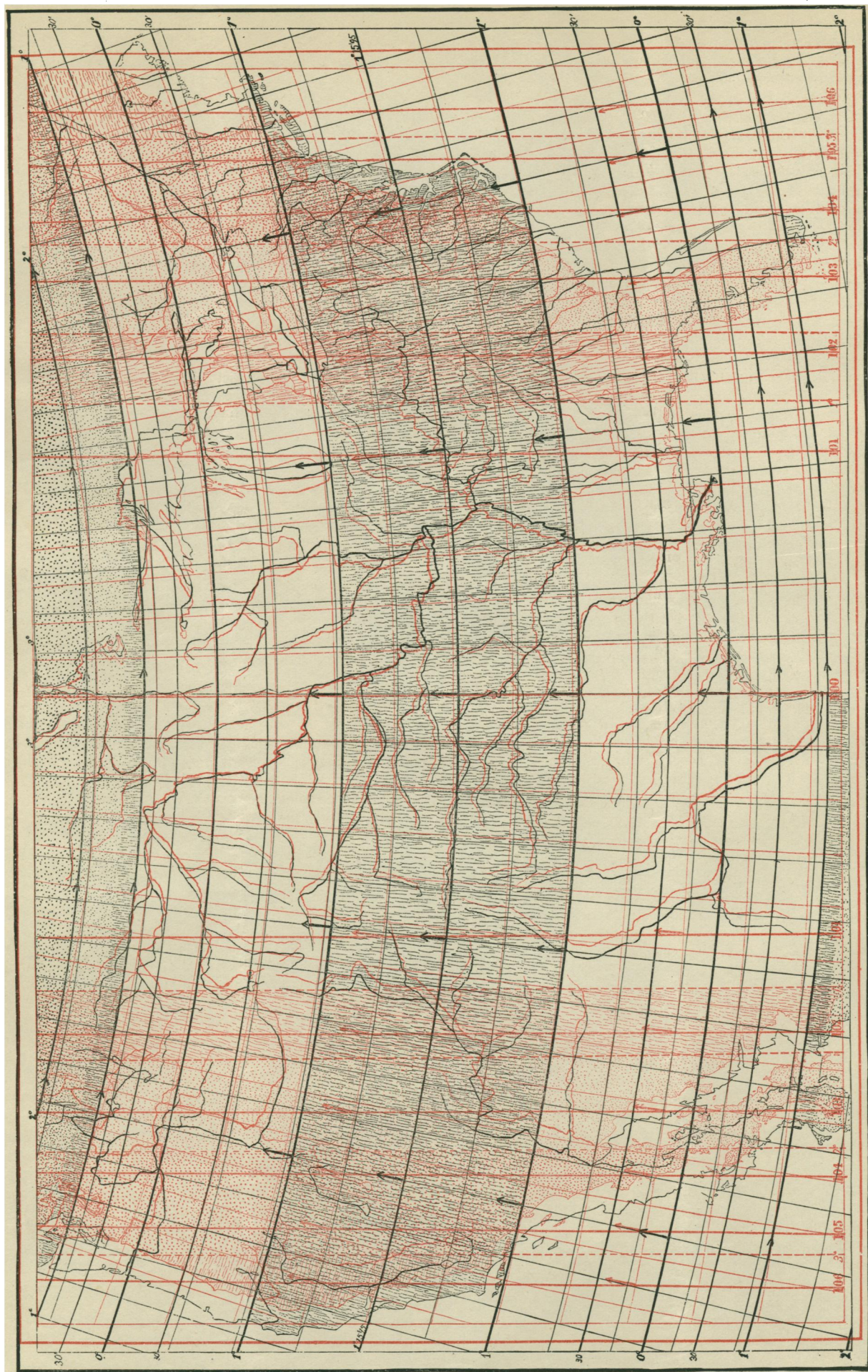
JAMES STEVENSON.

IN the death of James Stevenson on Wednesday, July 25, the public lost the services of one of the most active and indefatigable ethnologists of the time. Certainly, so far as knowledge of the aboriginal American race habits and customs is concerned, he contributed more than any predecessor, and by his keen appreciation of the subject and tireless investigation he saved from irreparable loss much of the evidence upon which must stand all we know of many of the ancient peoples of this continent and their polity.

From an article in a recent issue of the *National Tribune* of Washington we get the following facts relating to the life and labors of Mr. Stevenson. He was born at Maysville, Ky., in 1840, and his life was devoted to the one passion of geographical and ethnological research, except when interrupted by the war.

He went West first when quite a boy, several years prior to the Rebellion, with Professor Hayden, to the Missouri River country, making unofficial observations of Indian customs, and learning their dialects. Upon the breaking-out of the war, Professor Hayden entered the service as a surgeon, and young Stevenson enlisted as a private, and became a second-lieutenant of the Thirteenth New York Volunteers. He was at the second Bull Run, and was an important witness in the famous Fitz-John Porter case.

In 1866 he resumed his explorations, going to the Bad Lands of Dakota with Professor Hayden, as his assistant in the Geological Survey. Being a warm personal friend of the late Gen. John A. Logan, young Stevenson aroused in him a deep interest in the subject of developing a better knowledge of our Western lands. Logan, at Stevenson's suggestion, conceived the idea of establishing such a survey as a distinct and responsible branch of the general government, and from his place on the floor of the House, in the winter of 1866-67, he offered an amendment to the Sundry Civil Bill appropriating the sum of five thousand dollars for such an in-



Polyconic Projection in Red.

Conic Projection in Black.

— BY —
N. F. BOAS.